Group 1
NMP: Economic Return

I. Rationale and audience

II. Conceptualizing net benefits
   A. General background
   B. Three NMP illustrations
      1. embodied in technologies / products
      2. a new managerial process
      3. a validation process (risk)
   C. Relationship of performance measures and project selection criteria

III. Methodology and measurement

IV. Communication of results and peer review

V. Recommendations

Rationale

1. Benchmark and feedback for IPDTs and management

2. Accountability to the taxpayer, the Administrator, the Congress

3. Improve on mere “count” data and perverse incentives (e.g. maximize number of industry inquiries or number of cooperative agreements such as CRADAs)

4. Avoid benchmark of “job” creation (cost not benefit; poor measure for many smaller programs designed to improve human capital productivity)

5. Commensurate with quantitative focus in other programs in NASA and other agencies

6. Required by law (Government Performance and Results Act of 1993 (P.L. 103-62))
   also: 1980 Stevenson-Wydler Technology Innovation Act; 1986 Federal Technology Transfer Act; 1989 Bay-Dole University and Small Business Patent Act.

Background

1. Huge literature on measuring the returns to investment in research, development, and technology transfer (see Popper, 1995; Smith and Barfield, 1996; U.S. Congress, Office of Technology Assessment, 1986; Wagner, 1995; Griliches, 1984; U.S. Congress, Congressional Budget Office, 1994)

    -- estimate gains to productivity (Griliches, 1979; Solow, 1957)
    - --- econometrically estimated aggregate production funcitons
    - --- reduced forms (Mansfield and coauthors, 1977)
    - --- case studies (e.g. Evenson, Waggoner, and Ruttan, 1979; Macauley, 1995)

    -- bibliometric, patent, and stock market studies
    - --- diffusion of knowledge (publication, citation, and patent counts & distribution)
    - --- event study and capitalization of patents or government investment (Austin, 1993)
    - --- estimation of intra- and interindustry spillovers (Griliches & Lichtenberg, 1984; Levin and Resiss, 1988; Jaffe, Trajtenberg, and Henderson, 1993)

    -- other case studies (e.g., NASA spinoff approach)

2. Past actual practices largely “count” without “so what” or “at what cost and benefit” (for examples: Popper, 1995; Wagner, 1995)

    -- CRADAS, industry inquiries, number of publications, etc.

    -- analogous to problem in interpreting the number of web site hits

3. Industry R & D

Direct & Indirect Benefits: Illustration 1

science / research

Approach:
- in-situ
- remote sensing
- robotics
- computer modeling
- laboratory experiment

Query:
- climate change
- environmental science
- oceanography
- nuclear power
- solid state/condensed matter physics
- medicine/health

Approach:
- fly-by
- samplereturn
- penetrator
- observatory
- Earth rem. sen.
- soft lander
- network

Science Query:
- origin of universe
- fate of universe
- life elsewhere
- uniqueness of solar sys.
- settle the solar sys.
- characterize Earth as integrated environmental system

"Mars rocks"
ground-based astronomy

non-space applications

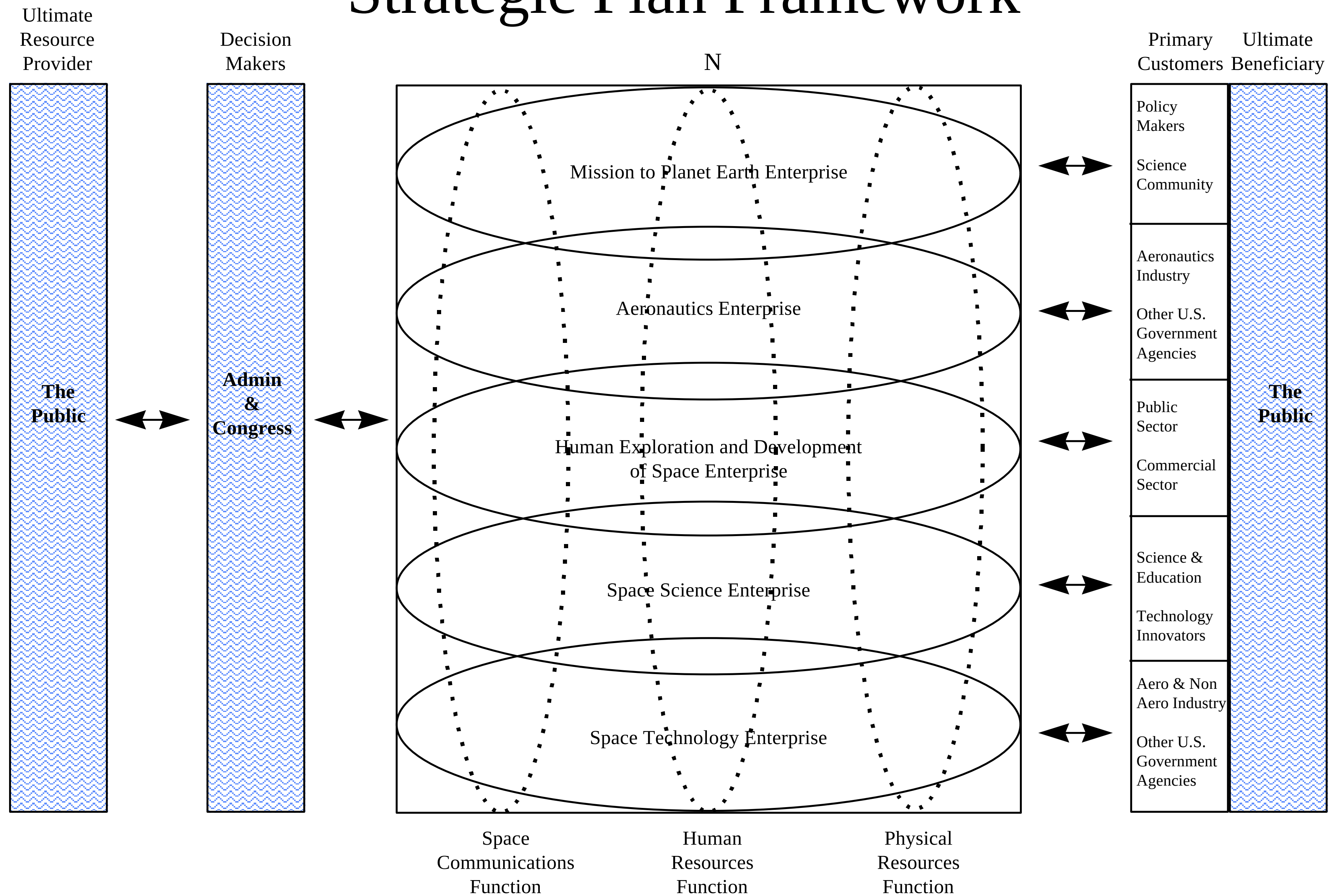
space applications

- telecommunications
- information technologies
- manufacturing
- energy
- transportation
- health care
- other consumer products

- aviation
- aerospace
- GPS applications

technology / products

Strategic Plan Framework



Sample of “Benefits” Listed in NMP Documents

- Order of magnitude reduction in operations staffing
- Reduces load on Deep Space Network
- Reduces tracking & spacecraft command, telemetry requirements
- Data collection 8-16x faster than with current spacecraft

- Synchronous science measurements on multiple spacecraft
- “Leap Ahead” (ion propulsion) - delta V
- Autonomous operations and minimum ground support

- Enables exploration of pooly-known places
- Facilitates “network” science

NMP Processes and Products

PAPC Benchmarking Meeting

	1	2	3	4	5	6	7
Process	**Formulate Capability Needs For 21st Century Science Vision**	**Identify/ Roadmap Enabling Technologies**	**Generate/ Refine/ Approve Validation Flights**	**Select/ Approve Technology Manifest**	**Implement Validation Flight**	**Analyze/Document Validation & Science Data**	**Transfer Technology to Potential Users**
Product	**Capability Needs List**	**Technology Roadmaps**	**Approved Validation Flights**	**Approved Technology Manifest**	**Returned Validation & Science Data**	**Documented Validation & Science Results**	**Technology Infusion for Lower Cost, More Capable Science Missions**

Direct & Indirect Benefits: Illustration 2

NMP as a different managerial approach

"integrated"
"product" + science + engineering
"team"

faster
better flow of information and ideas
cheaper

how much?

any scope for additional incentives to integrate,
link with products, diffuse technology?

Direct & Indirect Benefits: Illustration 3

Flight Validation

- Risk reduction
- Technology adoption

Risk justifies role of government (else request that industry suppliers do the validation)

Justifies “portfolio” approach

Requires NMP & NASA leadership to communicate, in advance,

what risk means in “faster, better, cheaper”--

that is, e.g., how will Congress view DS-1 “loss”?

“Redundant S/C” vs “Redundance on S/C”

“Success ° flip swith & it works”

Link “Benefits” with Selection Criteria (performance measures)

NMP Selection Criteria

A Impact on 21 st Century science

critical ⟷ valuable ⟷ no impact

B Revolunionary nature of breakthrough

new, orders mag. life-cycle cost reduction

⟷ <10-fold ⟷ incremental

C Risk reduction by flight validation

flight is necessary & sufficient to ensure future use

⟷ reduce perceived risk vs ground validation alone

⟷ no advantage over ground validation

0-3 for each of A,B,C

then: A x B x C = “Technology Value”

Recommendations

- Among myriad potential benefits (see 4-quadrant diagram), initial analyses should focus on space science

- Ensure that incentive-compatible mechanisms are in place to capitalize on other types of benefits (e.g., non-space technology applications)
    - inviate other-than-usual suspects to serve on "Industry Council" (e.g., Lucent, ADM, Intel)
    - offer a bounty to IPDTs who recruit from outside the usual community

- Sieze opportunities for knowledge and technology diffusion
    - involve graduate students with industry (e.g., Stennis' "university-industry affiliate program")
    - SBIR (timeline in NMP is very attractive)

- Develop white paper on NMP as a managerial approach
    - establish a "management IPDT"??

- Develop a white paper on risk in the context of "faster, better, cheaper"
    - disseminate and communicate
    - incorporate into reward structure for NMP team

- Take formal action from this workshop